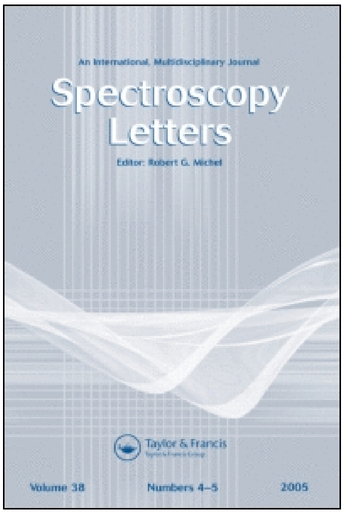

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Registration of Low Intensity Spectral Lines by Using the MC6840 Programmable Timer in Photon Counting System

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REGISTRATION OF LOW INTENSITY SPECTRAL LINES BY USING THE MC6840 PROGRAMMABLE TIMER IN PHOTON COUNTING SYSTEM

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ABSTRACT

Some problems about registration of low intensity spectral lines by using photon counting method are discussed. Application of the MC6840 Programmable Timer in automated data acquisition systems is described. A microprocessor based automated system for registration of spectral lines with piezoelectrically scanned Fabry-Perot interferometer is described. Algorithms are shown.

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INTRODUCTION

The modern optical spectroscopy experiment needs the use of computer technique and the automation of the spectral measurements requires a real time microprocessor control. That is why the questions connected with the optical signal analog - to - digital conversion, the methods of data acquisition and data processing and the feed - back realization are of great importance.

The registration of low intensity optical signals is of great interest because of the dark - current background emission. The photon counting method gives very good results (5) in low intensity registration where the photo receiver is a photo multiplier tube and the number of counts indicates the intensity of the optical signal. The photon counting method needs a TTL standardization of the anode pulses because they are with statistically distributed amplitudes. The scheme diagram of the standard photon counting system (1) used by us is shown on fig.1.

If a scanning registration is applied the period of photon counts acquisition defines the channel width when a preliminary statistical accuracy in channel is given. The bigger the number of the channels i.e. the smaller their width is, the bigger the accuracy on the scanning parameter becomes. The maximum number of the

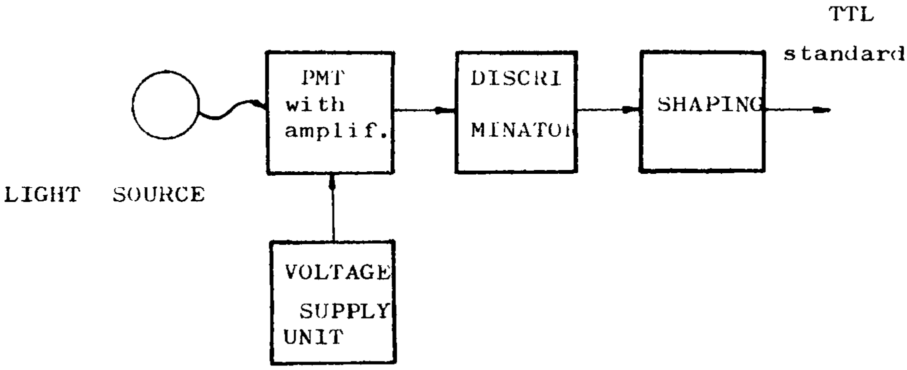

Fig. 1

Standard photon counting system

channels is limited by the computer memory potentialities and by the desired scanning parameter accuracy. There are several methods for channel width determination and for input discrete information accumulation when a photon counting method is applied. We will discuss the case when the MC6840 programmable timer is used (3). In this way it is possible to accumulate the infomation during 100% of the measurement time without loss of information. As it is well known (4) the MC6840 /PTM/ consists of three independent 16-bit binary counters. Each of the three counters within the PTM has external clock $\overline{C}$ and gate $\overline{G}$ inputs as well as a counter output line O. The continuous operating mode allows the counting to be controlled through the $\overline{G}$ input: $\overline{G}=\emptyset$ enables and $\overline{G}=1$ disables the counting. In our scheme rea-

lization the channel width is defined by the Timer Counter 3 which works in continuous normal 16-bit counting mode, with prescaler, internal E clock, with enabled output and enabled interrupt /CR36=1/. The 16-bit word written in the Timer 3 Latches defines the channel width.
It is evident that in this way the maximum channel width is 524 288 μS /65536x8/. If the channel width has to be larger an external pulse generator with frequency less than 1 MHz or an external frequency TTL divider has to be used. The output O3 monitors the Timer Counter 1 and 2 through their gate inputs. Since the Timer Counter 3 generates a square wave form Timer Counters 1 and 2 work consecutively depending on the Ø state of the inputs $\overline{G1}$ or $\overline{G2}$ - fig.2 and fig.3.

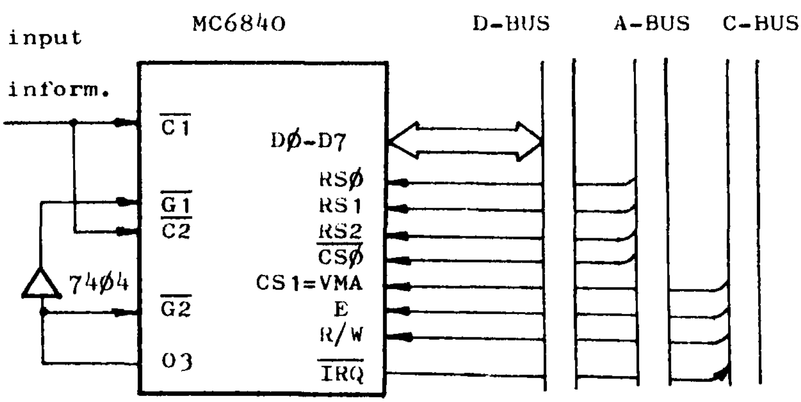

Fig. 2
The MC6840 used as a photon counter

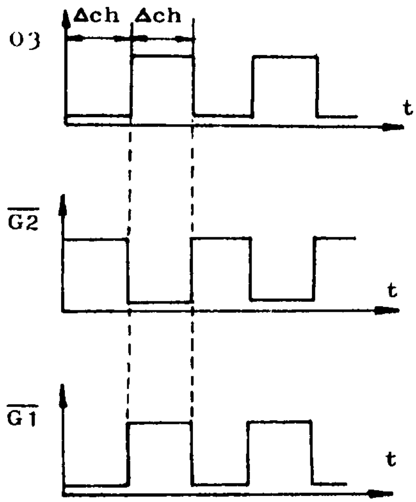

Fig. 3
Time-diagram illustrating the
MC6840 work as a photon counter

The data receiving procedure can be started by an interrupt request or by organising periodically test of the Bit 7 of the Status Register i.e. the Composite Interrupt Flag. In both the cases this flag goes up when a Time Out of the Timer Counter 3 occurs i.e. at the end of the formed time interval which defines the channel width.

The advantages of this method are as follows:

- The channel width is programmely determined and may vary in large intervals;

- The main programme may be arbitrary complicated independing on the channel width;

- There is no loss of information during the data interchange between the microprocessor and the periphery due to the synchronous work of the Timer Counters 1 and 2.

EXPERIMENTAL

Fig.4 shows a block diagram of automated system for low intensity spectral lines registration by means of piezoelectrically scanned Fabry-Perot interferometer. The bulgarian microcomputer IZOT 0220 /based on MC6800, Motorola/ stabilises the preliminary defined light source intensity, determines the momentum of the scanning start and accumulates the data. The channel width is programmely defined and depends on the rate of scanning and on the free spectral range of the etalon (7). The stabilization of the light source intensity is realized by means of a PIA /MC6821/ where side A controls a programmable d.c. supply unit (2) through an 8-bit Digital-to-Analogue Converter /DAC/ and side B receives the data from an 8-bit Analogue-to-digital Converter /ADC/. The information is received by the Programmable Timer MC6840 in the above described way. The start of scanning is programmely defined and it becomes when the necessary constant source intensity is reached. The Fabry-Perot interferometer is UFPS-1, DDR, coupled with a monochromator - SPM-2, DDR. The photo multiplier tube used for the photon counting system is of the type EMI-6094B. The home-made fast constant fraction discrimina-

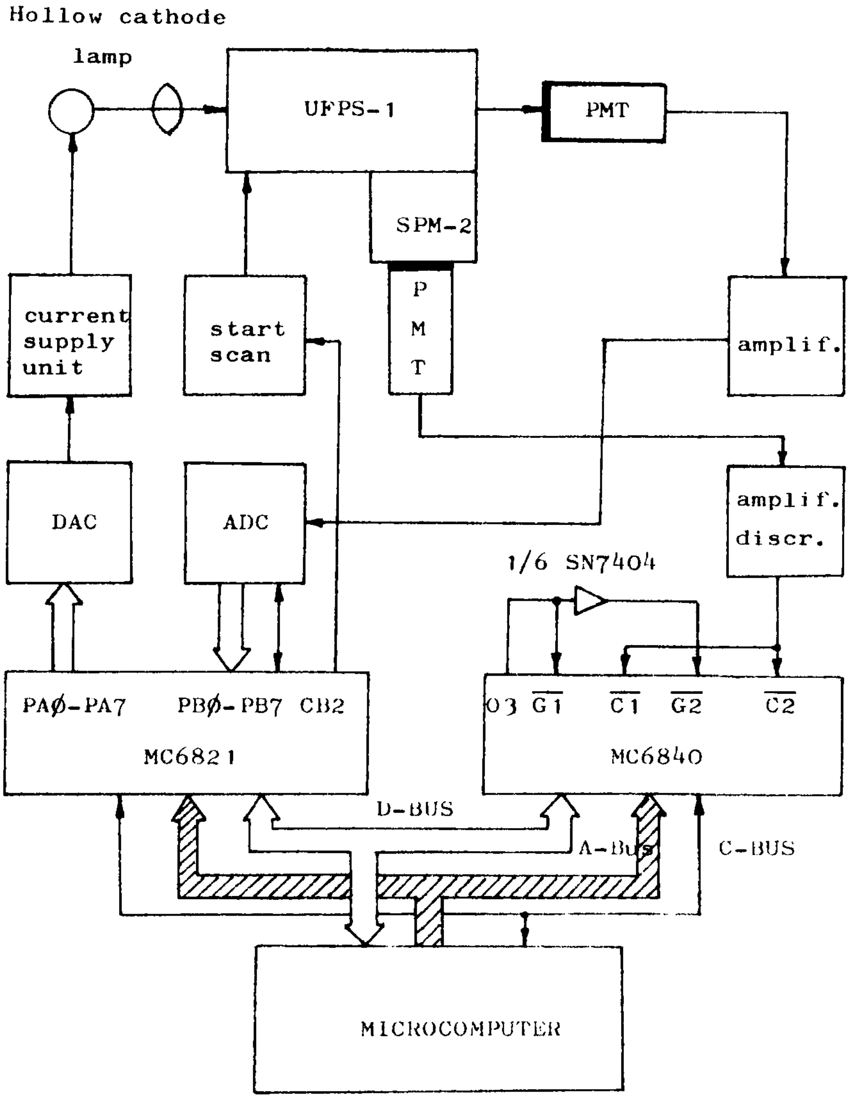

Fig. 4
Automated system for low intensity spectral lines registration using a Fabry-Perot interferometer

tors forming the standard TTL pulses are with self time resolution less than 150 pS. The light source is a hollow cathode lamp.

SOFTWARE

An ASSEMBLER programme is created for the system control. The algorithm is shown on fig.5.

After the system initialization the main programme for the source intensity stabilization is started. When a preliminary defined steady source intensity is reached the interferometer scanning is started. After a time interval /for hysteresis elimination/ the data acquisition begins, the interrupt is enabled and the microcomputer returns to the main programme. After each time interval equal to Δch an interrupt request via $\overline{IRQ}$ line starts the Receive Data Subroutine which transfers the stored information from the timer counters to the appropriate memory location. At the end the next memory address /channel/ is prepared. Reaching the last channel the system is switched-off automatically.

RESULTS

On fig.6 is shown the isotopic structure of Cd 479,92 nm line registrated without computer stabilization and on fig.7 is shown the same line registrated with our automated system. The maximum deviation between the peaks is 8,5% from the deviation

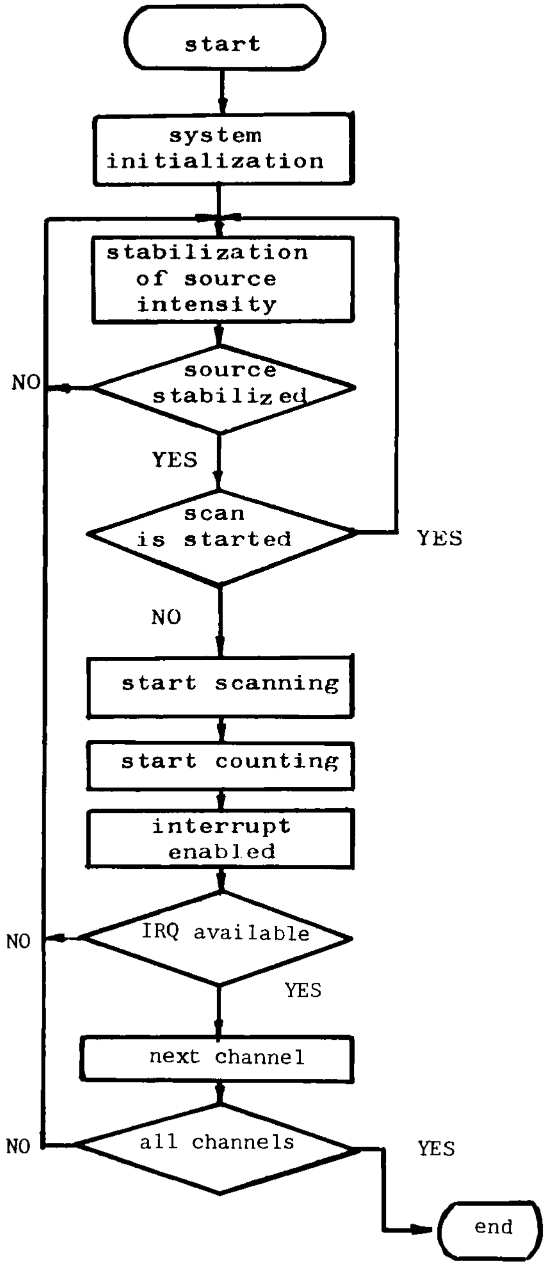

Fig. 5

Algorithm of the programme for the system control

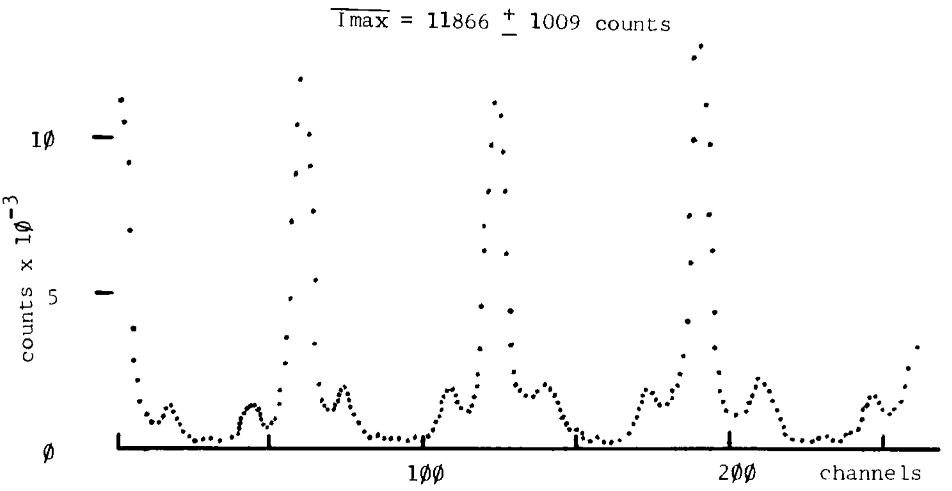

Fig.6

Isotopic structure of Cd 479,92 nm without computer stabilization of the source intensity

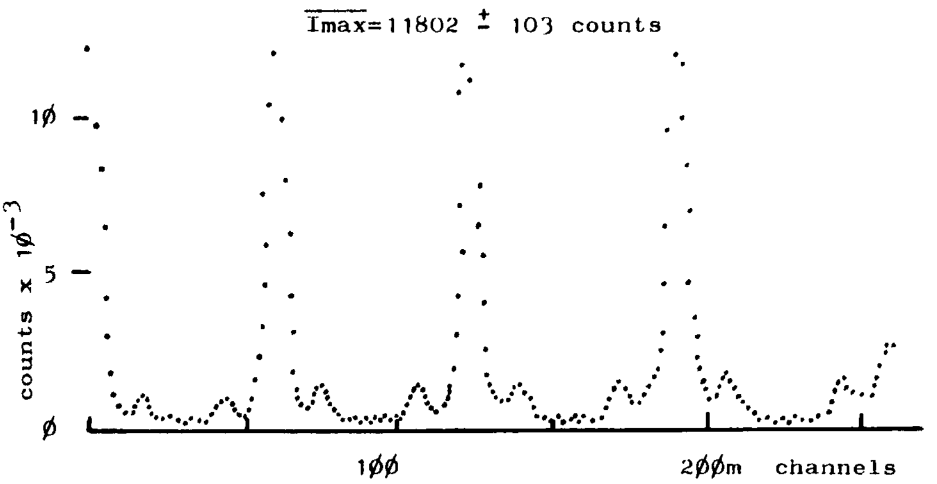

Fig.7

Isotopic structure of Cd 479,92 nm with computer stabilization of the source intensity in the first case and it doesn't overcome the statistical channel accuracy as well. As a conclusion we can say that the photon counting system with MC6840 is versatile, reliable and gives maximum accuracy.

REFERENCES

1. Dunchev L.S.,Petrakiev A.,Mohamad S.Z.,Mandjukov T. Registration of low intensity spectral lines with Fabry-Perot interferometer by photon counting method, Spectroscopy letters, 13, (6), 1980, 407-417.

2. Look D.C.,Farmer J.W., Ely R.N., Automation of a popular monochromator,Rev.Sci.Instrum.51(1980),No7,968-971.

3. Motorola M6800 Microprocessor Application Manual Motorola Semiconductor Products, Inc., 1975.

4. Nozeran J.-M.,Phan S.,Un cirquit d'horologe programmable:le TIMER 684ϕ,Micro-systems,Janv.-Fevr.,1981,82-88.

5. Perchev A.N.,Pisarevski A.N.,Odnoelektronnie haraktеristiki photoumnojitelei i ih primenenie,Moskwa,Atomizdat 1971.

6. Hutcheson Randy,Understanding PIA operation increases your design options, EDN,September,20,1980,175-183.

7. Yamada m.,Ikeshima H.,Takahashi Y.,Microcomputer Based Data Acquisition and Stabilization System for Piezoelectrically Scanned Fabry-Perot Interferometer, Rev.Sci. Instrum. 51 (1980),No4,431-434.

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